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ABSTRACT

This workplace skills course on mathematics is a review of basic number concepts focused on helping participants to understand and be able to record filling level data accurately. The introductory materials in the curriculum guide include a course outline, course objectives, a topical outline, information on course length and continuing education units, and resources. Lesson plans for six sessions are provided on the following topics: decimals (place value/addition/subtraction/multiplication); decimals (rounding/order); metrics; specific gravity; averages; calculators; weights; percents; tolerance; and estimation. The session materials include objectives, topics, methods, evaluation criteria, a pretest, information sheets, and handouts. (KC)



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ED 388 792

MERCER COUNTY COMMUNITY COLLEGE

TRENTON • NEW JERSEY

# Math for Quality Control

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# P.R.I.D.E.

## PEOPLE RETRAINING for INDUSTRY EXCELLENCE

CE 070 176



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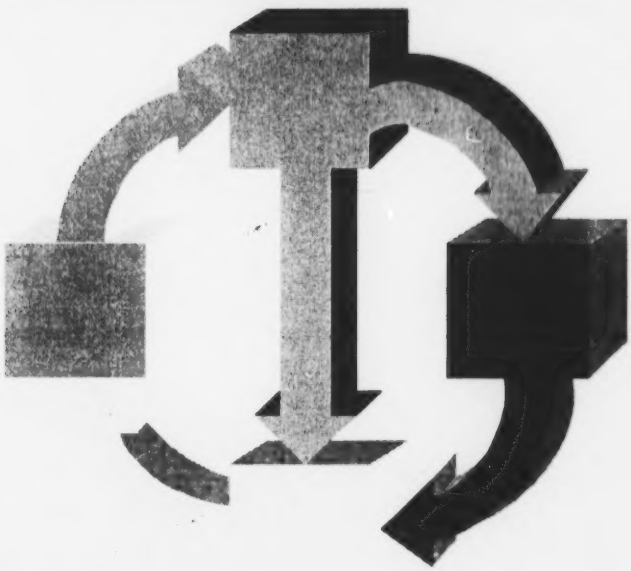
# Math for Quality Control



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National Workplace Literacy Program

**1995**

## ACKNOWLEDGMENT

Mercer County Community College thanks Jean Meier, Senior Education Specialist/Curriculum Developer for creating this manual. Through her valuable contributions employees in manufacturing and service industries learned concepts relevant to their existing jobs and strategies for learning other tasks if that opportunity should arise.

## *WORKPLACE SKILLS TRAINING PHILOSOPHY*

A factory or service center creates a classroom that is very different from the one we are used to seeing in colleges and adult schools, so it only follows that our approach to teaching in the factory should also differ.

Our goal is to teach employees skills that they need in order to be functional and successful in their work environment, and encourage them to apply those skills on the job and at home. For example, we motivate students to do the following:

- work more efficiently and more safely
- make fewer mistakes
- solve problems working interactively
- take greater responsibility for their jobs
- recognize the interconnectedness of the various jobs in their workplace
- be better communicators in the workplace

Company needs are revealed through a needs assessment. At that time, we also determine the basic skills needs of the employees. We are learner centered, as the individual employee's needs are considered alongside those of the company.

Once we have determined those needs, we develop curricula that incorporate basic skills, using the workplace literature (e.g. forms, applications, codes, abbreviations, charts and tables, handbooks, regulations, procedures, policies, memos, letters) of the company. Because each company is different, the needs and literature are also different; hence, we develop new materials for every company in which we teach. By utilizing these workplace items, we help students transfer and apply their skills directly to their jobs.

We rely on the classroom techniques of problem solving, cooperative learning, and group discussion. Our overall approach is concept based, with the emphasis on application, such as in role plays, dialogues, and group work. Despite the specific course titles, we incorporate the elements of math, English, and communication skills into all of our sessions.

In terms of students evaluation, after initial testing we give a pre-test and post-test in order to determine comprehension. Students receive feedback throughout the course from the instructor, as well as from fellow students as we sincerely believe in the powerful positive reinforcement of peer critiques and cooperative exchanges.

In essence, we believe that although we make the materials for the students with which to work, it is the students who truly make the class.

# *MATH FOR QUALITY CONTROL*

## COURSE OUTLINE:

This course is a review of basic number concepts focused on helping participants understand and be able to accurately record filling level data. Strategies are provided for increasing accuracy when doing computations with decimals and percents. Rounding and averaging will be covered together with metrics and specific gravity. Participants will be trained in determining when fill levels are outside of required specification limits so that appropriate action can be taken to remedy the situation.

## OBJECTIVES:

Upon completion of this course, students will be able to:

- perform basic operations involving decimals and percents
- round numbers
- perform mental arithmetic
- calculate averages
- accurately weight tubes and record the data
- compare data with minimum and maximum limits to determine if tube weights are within required specifications

## TOPICAL OUTLINE:

- rounding
- estimating
- averaging
- computations with decimals
- per cent concepts
- metric system
- weights and measures
- specific gravity

# *MATH FOR QUALITY CONTROL*

## OTHER:

- Hours: 12
- CEU: 1.2

## SOURCES:

Mitchell, Robert. **Math Skills that Work, Book One.** Chicago: Contemporary Books, 1991

# *MATH FOR QUALITY CONTROL*

## COURSE OUTLINE

**Session 1**

- Pretest
- Overview/rationale of the training
- Practice filling out information about the batch
- Decimals (place value/addition/subtraction/multiplication)

**Session 2**

- Decimals (rounding/order)
- Metrics
- Specific Gravity

**Session 3**

- Averages
- Use of the memory function on a calculator
- Practice weighing empty tubes and recording data
- Calculation of tare weight and minimum fill weight

**Session 4**

- Review of percents
- Calculation of maximum fill weight

**Session 5**

Tolerance
Practice weighing filled tubes
Calculate average weight
Determine if weight is within specifications

**Session 6**

- Practice with the complete process
- Use estimation to catch mistakes
- Posttest

## *MATH FOR QUALITY CONTROL ♦ SESSION 1*

### OBJECTIVES:

Upon completion of this session, students will be able to:

- add, subtract and multiply decimals

### TOPICS:

- pretest
- overview of the training
- arithmetic operations with decimals

### METHOD:

- lecture
- completion of pretest
- practice recording data from workorders

### EVALUATION:

- evaluation of accuracy of information recorded

### MATERIALS:

- pretest
- workorders
- Filling Level Data forms
- handouts

## *MATH FOR QUALITY CONTROL ♦ PRETEST*

1. Which is larger: .1 or .03?

   _____

2. Put these numbers in order from smallest to largest:

   9.9 98.7 0.9 9.0 99 0 .03 .1 9

   ____ ____ ____ ____ ____ ____ ____ ____

3. What is .01 X 220?

   _____

4. Find 1 % of 220g.

   _____

5. What is 3% of 220g?

   _____

6. In the number 39.18 what place is the 1 in?

   a. tenths b. hundredths c. thousandths d. ones

   _____

7. Find the average of: 56.8 and 53.6 and 59g. Round your answer to the nearest tenth.

   _____

## *MATH FOR QUALITY CONTROL ♦ PRETEST*

8. Subtract: .15 from 20.

_____

9. A recipe calls for 200 grams of an ingredient. Your supervisor tells you to add 3% more. How much extra should you add?

_____

10. How many ml. in one liter?

_____

11. Write the following numbers:

- three tenths _____
- four hundredths _____

12. Which of the following would be measured with milliliters (ml)?

- the volume of paint in a tube?
- or the weight of a filled tube of paint? _____

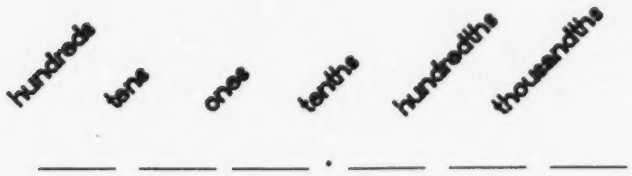
13. Round the following number to the nearest hundredth: 98.1266666666

_____

# DECIMALS

To read a decimal fraction, read the number as a whole number, then say the name of the place value where the last digit falls. A decimal point is read "*and*".

| | |
|---|---|
| 0.9 | is read as 9 tenths |
| 0.12 | is read as 12 hundredths |
| 5.008 | is read as 5 and 8 thousandths |




The value of a number is determined by its place or location compared to the *decimal point*. Thus 0.5 has the same value as .50 but it is not the same as .05.

Circle the largest number in each pair:

| | |
|---|---|
| .1 | .05 |
| 0.6 | .06 |
| 8 | 8.0 |

The decimal point is usually not written in whole numbers but it can be put in.

Where would you put a decimal point in the whole number 76 ?

What is half of .1?

# OPERATIONS WITH DECIMAL NUMBERS

A. Addition/Subtractions Skills
- add/subtract decimals, mixed decimals and whole numbers

Adding/subtracting decimal fractions

To add/subtract decimal fractions:

1) arrange the numbers so that the decimal points are directly under each other,

2) add, as with whole numbers and

3) place the decimal point in the answer directly under the other decimal points.

e.g. Add 5 + .02 Subtract 3.07 − .005

| | |
|---|---|
| 5. | 3.070 |
| + .02 | − .005 |
| 5.02 | 3.065 |

Note: To reduce the possibility of error, place zeros in all place values which have no digits.

# *OPERATIONS WITH DECIMAL NUMBERS*

B. Multiplication Skills
- multiply decimal numbers

Multiplying Decimal Numbers

To multiply decimals, multiply using the same procedure as with whole numbers. Place the decimal point in the answer the same number of decimal places as there are in both numbers being multiplied.

| | | |
|---|---|---|
| e.g. | 50.123 | (3 places) |
| | x 0.87 | (2 places) |
| | 43.60701 | (5 places) |

## *MULTIPLICATION TIPS*

.01 means **one hundredth** therefore

***multiplying by .01*** is the same as ***dividing by 100***

To multiply by .01

***move the decimal point two places to the left***

Example: .01 X 10.4 = .104

.03 is **three times** .01 therefore

To multiply by .03

***1) move the decimal point two places to the left***

***2) multiply by 3***

Example: .03 X 10.4 =

1. move the decimal two places to left .104
2. multiply by 3 .312

## *MATH FOR QUALITY CONTROL ♦ SESSION 2*

### OBJECTIVES:

Upon completion of this session, students will be able to:

- round decimals
- use the metric system
- understand specific gravity

### TOPICS:

- rounding decimals
- metrics
- specific gravity

### METHOD:

- lecture
- discussion of worksheets
- groupwork

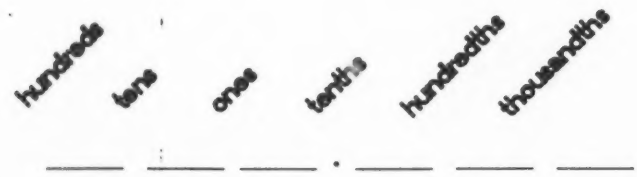
### EVALUATION:

- self evaluation based on discussion of the work sheets

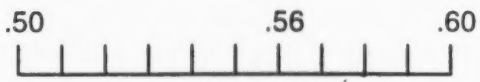
### MATERIALS:

- handouts: Working With Decimals
  Metrics
  Specific Gravity

# *ROUNDING*




Round .56 to the nearest tenth:




.56 is closer to .6
round *up*

To round a decimal fraction, determine the number of decimal places required,

- if the digit to the right of this decimal place is less that 5, eliminate all the digits following it.

  e.g. round 5.318 to the nearest tenth

  5.318 = 5.3

- if the digit to the right of this decimal place is 5 or more, add one to the last required digit and eliminate all the digits following it.

  e.g. round 5.368 to the nearest hundredth

  5.368 = 5.4

# *DECIMALS*

1. Write a number for each of the following:

   a) five and two hundredths _____

   b) sixty-five thousandths _____

   c) three and four tenths _____

2. Round each number to the tenths place.

   a) 130.125 _____

   b) 12.0731 _____

   c) 5.666666 _____

   d) 43.02333 _____

# *METRICS*

In the metric system the root word used indicates what is being measured:

- **Liters** are used to measure **liquid volume**
- **Grams** are used to measure **weight**
- **Meters** are used to measure **distance**

**The same prefixes are used with each root word:**

| **Kilo** | Hecto | Deka | **Unit** | Deci | Cent | **Milli** |
|---|---|---|---|---|---|---|
| | | | Liter | | | |
| | | | Gram | | | |
| | | | Meter | | | |

Measurements get 10 times larger each place you go to the left

☞ *or*

10 times smaller each place that you move to the right.

☞ *therefore*

You can convert from one unit to the other by simply moving the decimal point one place left or right for the number of places you move left or right on the chart

1. Is a kilogram (kg.) larger or smaller than a gram (g)? By how much?

2. Is a milliliter (ml.) larger or smaller than a liter (L)? By how much?

3. For instance 83g. would be _____ kg. (move the decimal point 3 places to the left)

4. Try the following:

| | | | | | |
|---|---|---|---|---|---|
| 81g. | = | kg. | 671ml. | = | L. |
| .34kg | = | g. | .475L | = | ml. |

5. What units are used on the label of a tube of paint? Why?

# *SPECIFIC GRAVITY*

The **density** of a material is its mass (or weight) per unit of volume. For example, a one inch cube of cork is very light. A cube of iron the same size is much heavier. Therefore iron has a much higher density than cork.

**Specific gravity** is often used instead of density for the purpose of comparing materials.

Specific gravity is defined as a comparison of the density of a substance to the density of water. Specific gravity has no units.

$$\text{Specific Gravity} = \frac{\textit{Density ot material}}{\textit{Density of water}}$$

The density of water is:

⇒ one gram per milliliter — 1ml. of water weighs 1g.

or

⇒ one kilogram per liter — 1L. of water weighs 1kg.

Therefore, if the specific gravity of a substance is 1.2 then

⇒ 1ml. would weigh 1.2g
⇒ 1L. would weigh 1.2kg.

---

**Volume (L.) X S.G. = Weight (Kg.)**

***OR***

$$\frac{\textbf{Weight (Kg.)}}{\textbf{SpecificGravity}} = \textbf{Volume (L.)}$$

---

The table below gives a comparison of some common substances with water:

| Substance | Specific Gravity |
|---|---|
| Copper | 8.9 |
| Ice | 0.9 |
| Oil | 0.9 |
| Water (at 39° F) | 1.0 |

## *MATH FOR QUALITY CONTROL ♦ SESSION 3*

### OBJECTIVES:

Upon completion of this session, students will be able to:

- compute averages
- use the memory function on a calculator
- weigh empty tubes and record the data
- calculate tare weight and minimum fill weight

### TOPICS:

- averages
- use of a calculator
- using a scale
- tare weight
- minimum fill weight

### METHODS:

- guided discussion
- groupwork: weighing empty tubes and recording data

### EVALUATION:

- self evaluation based on accuracy of data calculated and recorded

### MATERIALS:

- scales
- handouts

# CALCULATOR

To erase the display when you begin a new problem or to erase a keying error –

| | |
|---|---|
| C | Clear |
| CE | Clear Entry |
| AC | All Clear |
| CM | Clear Memory |
| MC | Memory Clear |
| $M^{R}_{C}$ | Recall Memory (press the key once)<br>Clear Memory (press the key twice) |

Memory Keys

| | |
|---|---|
| M+ | Add to the Memory |
| M– | Subtract from the Memory |
| RM | Recall Memory |

*Examples:*

To get a final total –

- ▲ Add each subtotal to the memory
- ▼ Recall the memory to get the final total

1.3 X 57 M+

$$7.4 + 7.3 + 7.5 = \frac{\qquad}{22} \div 3$$ M–

RM

# *AVERAGES*

To compute an average:

- Add up all the values
- Divide by the total number of items
- Round your answer if necessary

*Example:*

Find the average of 79.5, 81.6, and 80

1. 79.5 + 81.6 + 80 = 241.1
2. 241.1 ÷ 3 = 80.366666
3. Round your answer to 80.4 or 80.37

**Your average should always be in the middle between your highest and lowest values**. If your average is higher than your highest value or lower than your lowest value, something is wrong.

Some of the averages below are correct. Some are incorrect. Without doing any calculations see if you can spot the ones that are wrong.

| | | | | Average | Incorrect or correct? |
|---|---|---|---|---|---|
| A. | 79.3 | 82.6 | 81 | 82.9 | |
| B. | 156.2 | 157 | 150 | 154.4 | |
| C. | 8 | 7.7 | 7.8 | 8 | |
| D. | 11.4 | 11.1 | 11 | 11.2 | |

## *MATH FOR QUALITY CONTROL ♦ SESSION 4*

### OBJECTIVES:

Upon completion of this session, students will be able to:

- calculate maximum fill weight
- catch mistakes using estimation

### TOPICS:

- percents
- mental arithmetic

### METHOD:

- lecture
- discussion of worksheets
- groupwork

### EVALUATION:

- self evaluation based on discussion of the work sheets

### MATERIALS:

- handouts

# *PERCENTS*

Percent means per hundred out of a hundred ***or*** divided by a hundred

☞ therefore

5% can be written $\frac{5}{100}$ or 5 ÷ 100 or .05

To find a percent of a number:

1. Change the percent to a decimal
2. Multiply

Example:

Find 3% of 10.4

1. Change 3% to .03
2. Multiply .03 X 10.4
   = .312

To find what percent one number is of another number:

1. Divide (Part ÷ Whole)
2. Change to a percent

Example:

What percent is 3 out of a total of 400?

1. Divide: 3 ÷ 400 = .0075
2. Change to a percent: .0075 = .75%

## *MATH FOR QUALITY CONTROL ♦ SESSION 5*

### OBJECTIVES:

Upon completion of this session, students will be able to:

- weigh tubes
- calculate average weight
- determine if weight is within specifications
- write directions that explain the entire process

### TOPICS:

- weighing tubes and determining if they fall within tolerance limits
- explaining the process in written form

### METHOD:

- lecture
- groupwork

### EVALUATION:

- self evaluation based on accuracy of calculations

### MATERIALS:

- handouts

## *MATH FOR QUALITY CONTROL ♦ SESSION 6*

### OBJECTIVES:

Upon completion of this session, students will be able to:

- complete the entire Filling Level Data forms
- use estimation to catch mistakes

### TOPICS:

- practice completing forms
- mental arithmetic
- posttest

### METHOD:

- lecture
- groupwork: finding mistakes on already completed forms

### EVALUATION:

- self evaluation

### MATERIALS:

- completed forms with mistakes

## *PRODUCTION*

In a particular day the following weights of tubes of paint were recorded:

| Time | Weight (g) | | |
|---|---|---|---|
| 9:00 AM | 87.0 | 88.1 | 87.6 |
| 9:15 | 90.1 | 91 | 90.3 |
| 9:30 | 96.3 | 94.7 | 95 |
| 9:45 | 91.8 | 89 | 90.9 |
| 10:00 | 92 | 91.6 | 92.1 |
| Empty tubes | 9.3 | 9.4 | 9.1 |

1. Use this data to fill out the Filling Level Data form.

2. Are all these weights within required specification levels?

## Filling Level Data

| Product Code | Date | |
|---|---|---|
| Product | CF # | |
| NJ # Batch OK by | Machine # | Quantity |
| | Correct Tube and Label | OK to start run by |

_____ (Specific Gravity) x _____ (Theoretical Volume) = _____ Calculated Weight

\+

_____ + _____ + _____ = _____ (Total) ÷ 3 = _____ Tare Weight
(Empty Tube Weights)

=

_____ **Minimum Fill Weight**

Specifications: _____ (Minimum Fill Weight) x 1.05 = _____ **Maximum Fill Weight**

| Time | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | | | | | | |
| Average | | | | | | | | | | | | | | | | |
| Range | | | | | | | | | | | | | | | | |